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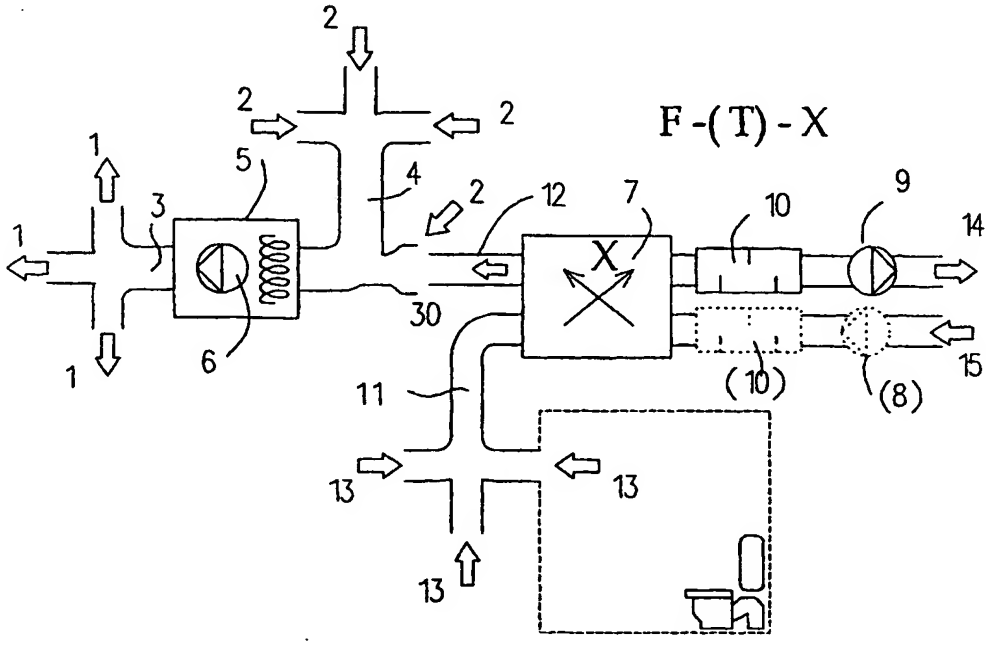
(54) Title: ARRANGEMENT FOR AIR INTAKE



(57) Abstract: A ventilation arrangement for a building, comprising an exhaust air duct (11) with a fan (9), a supply air opening (22) for outdoor air (15), and an air circulation installation for circulating of air (1, 2) in the building, wherein the circulation installation comprises a circulation duct (3, 4; 21, 24) with a fan (6), where the duct of the air circulation installation has a first inlet opening (30) upstream of the fan for intake of circulation air (2) from interior of the building, and a second inlet opening (22), which is positioned upstream of the fan for intake of outdoor air (15).

Arrangement for air intake

The invention concerns an arrangement for outdoor air intake of the kind which is specified in the preamble of the patent claim 1.

Generally known about ventilation arrangements of today's technology

In a one-family house, in which this invention will be used, an over pressure always arises in the upper parts of the house caused by temperature differences outdoors and indoors. Particularly in two-storey houses, (or more stories) with openness between the different floor levels, in cold weather the house forms, by means of its large inner height, a large hot "air-column" which creates a considerable over pressure in the topmost parts of the building.

This can easily bring about serious problems if indoor air is forced out into the framework, for example forming of mould in roof insulation, roof trusses and in the roof cover.

In order to prevent humid indoor air penetrating the framework it is desirable that a vacuum maintains inside the house. Therefore often an exhaust air fan is used to ventilate the house.

But it is also difficult to build a house so hermetic that the air does not takes a wrong route when entering the house. In order to reduce propelling forces causing unintentional penetration of outdoor air, you use, as complement to the exhaust air fan, a supply air fan which reduces the vacuum inside the building. Also to guide the incoming outdoor air the correct way into the house. For example through the roof insulation so-called dynamic insulation or dynamic fresh outdoor intake. The idea of this is to "catch" the energy which otherwise will leak out through the roof insulation conducted by the fibres. Or, for example, to guide the incoming outdoor air through a heat exchanger for energy exchange with the out going exhaust air.

The exhaust air fan therefore is given a slight bigger capacity compared to the supply air fan to maintain a vacuum inside the residence. Also to prevent indoor air penetrating the frame work and causing damage.

However a supply air fan, with an appurtenant silencer, raises the price of the installation. It is noisy and consumes a great deal energy.

When using dynamic fresh air intake the air flow through the heat insulation must cover the entire surface and be spread as evenly as possible to be able to return the outwards leaking heat backwards into the house again.
Therefore there is an additional layer inside the air permeable insulation layer. This layer is also air permeable, but with a stronger air resistance. This air resistance layer is necessary to give required spreading of the intake over the entire surface.
Therefore a rather heavy vacuum must be created inside a space arranged below the insulation and the resistance fabric. With this invention this vacuum can be created without the use of a supply air fan.

A system with circulating indoor air

It must also be mentioned, according to known technology, a not so known phenomenon of airborne heat systems for heating and ventilation.
The circulation air fan for circulating indoor air can at incorrectly performed installations unintentionally be forced to press in a greater quantity of air into the house, than the exhaust air fan can manage to evacuate.
You can not anyhow conduct cold outdoor air between an air filter for circulating indoor air and a heat unit with a fan, or conduct outdoor air too close to a heat unit, without the risk that an over pressure occurs inside the building.
In winter time cold outdoor air expands considerably when being heated on intake into a building, and receives a considerably greater volume than it had outdoors.
You always give the circulation air fan a bigger capacity than the exhaust air fan because the circulation air fan is dimensioned to transport a considerably larger quantity of air.
When over pressure occurs, a very dangerous condition will arise if humid indoor air forces out into the framework, resulting in for example mould fungus forming inside walls and roof.

An additional problem arises if you locates a filter next to, or behind, the circulation return air opening. I.e. before the supply duct of the outdoor air.

The air filters block regularly as the filters takes care of all dust which flies around in the residences. At the least failure to clean or change filters, these work as a tightened wall. The effect is that the outdoor air is sucked in by the powerful circulation air fan, it leads into the heat unit and expands when being heated. In doing so a big over pressure arises inside the building and gives similar conditions which was described above.

The ideal for such systems is an open design. So that the circulation inside the building will be independent, and that the supply air and the exhaust air flows for ventilation are also done independently and in controllable cooperation with each other.

But as the equipment for circulation inside the building is already present, and available to be used, and can be utilised for the ventilation air distribution, then you can save a quantity of costs when letting the ventilation air accompany the circulation air around to the different parts of the house.

The invention before us means that above problems are entirely or partially removed.

The solution

The proposed system design works also without help of, or the need for, an expensive and disturbing supply air fan.

The result is a very simple solution with great possibilities to be varied.

The purpose of the invention obtains with a ventilation arrangement performance according to the enclosed patent claim 1 / patent claims.

Several different performances of the arrangement are stated in the enclosured independent patent claims.

A performance design is to let the circulation air work, propelled by the circulation air fan, and suck in the outdoor air into the building in a well-balanced quantity and without letting an over pressure arise inside the building.

One performance of this is to utilise a higher air speed inside the the circulation air duct compared to an another part with less air speed. It will soon be seen in this invention that this second part not always need to be located straight inside the circulation air duct but can be located in connection to it.

It is well-known through Bernoulli's equations that if you increase the air speed, in a continuous flow, for example in a delimited duct system, the pressure falls, as energy balance always prevails. In other words: if the velocity energy increases then the pressure energy decreases. Higher velocity gives a lower pressure.
This phenomenon is utilised in so-called ejector pumps. For example in deep-drilling wells where a circulating body of water, with help of two tubes, is forced through a spray nozzle with holes in the flank in the narrowest part and where new water from the well is sucked in.
Such installation is constructed to transfer as much water as possible and in result give a considerable pressure in order to load a pressure tank for storage.
The pump motor propels constantly around the water-circulation flow unchanged on the whole.

Our invention utilises a velocity increase or an ejector effect in a circulating (air)mass for sucking of new fresh outdoor air, but there ends the conformity. The duct system for the circulating mass consists of the the building itself and includes the circulation return- and supply-air ducts.
Inside the building prevails, as you know, different air pressure on different height levels which gives entirely other conditions than the compared water pump installation.
The "ejector pump" of this invention shall not create such a big pressure as possible, or a so big air flow as possible, but will create a pressure which is less than the counter pressure the indoor air forms at the topmost levels of the building, to ensure that the outdoor air will enter the building the correct way and not through leaks.
The quantity of ventilation air which passes through the building is controlled by the exhaust air fan and the suction effect it creates inside the building.

The invention used in conventional system with supply air and exhaust air in sheet metal ducts:

A solution according to the invention is suitable for conventional duct systems with supply air and exhaust air in continuous tubular sheet metal ducts with relatively small air flow and therefore week propelling force for pump effect.
Consider a continuous tubular sheet-metal duct, so-called spiro-duct.
With the presumption that the density of the air will not be changed, Bernoulli's equation gives at a dimension change, from a standard diameter Ø315 mm to Ø250 mm, the pressure proportions:

$(p2 / p1) = (c1 / c2)^2 \Rightarrow (p2 / p1) = (d2 / d1)^4$

$(p2 / p1) = (250 / 315)^4 = 0,41$

Where p = pressure; c = air speed; d = diameter.
The pressure p2 is in the example 41% of the pressure p1.
When mixing outdoor air in the narrow part the pressure difference will of course be influenced.

It is obvious that the outdoor air duct can be given a small dimension at this performance, for example the same or a less dimension than if a supply air fan had been used.
To prevent the outdoor air from rushing into the residence, the outdoor air duct is equipped with a strangulation, for example an adjustable damper.
The idea is still that the exhaust air fan shall move the air out of the house in order to maintain a slight vacuum inside the living rooms.
This approach can be used advantageously in so-called heat recovery installations where the supply and the exhaust air for ventilation changes energy in a heat exchanger.
A so-called FTX-installation* with compulsory inspection transfers with maintained qualities to a FX-installation without compulsory inspection, owing to the serviceability of the installation.

* (F= an exhaust air fan; T= a supply air fan; X= a heat exchanger)

Another solution according to the invention to manage the above problem is to mix the different air masses before the heat unit in an open connection. The outdoor air conducts into or next to

an inlet opening for returning circulation air. This utilises the pressure decrease which arises because of the velocity increase close to the inlet opening of the returning circulation air.

The invention used in systems with indoor room circulating air with supply air through structural floors.

In the following we describe a fundamental solution for an installation of air borne heat with circulating indoor air in an one-storey house or a two-storey house or for an apartment or a delimited space in a larger building (fire cell).

This installation consists in principle of a vertical ventilation duct, with its upper part for return air, conducting to a heat unit, and from the heat unit to a supply part emerging into a double layered structural floor.

The structural floor works as a supply air duct for the circulation air and gives warm floors.

The supply air transfers up and into the residential areas behind the skirting-boards arranged at a distance from, and around the outer walls.

Important to note is, that there is in fact no air resistance to speak about in the installation except for inside the circulation duct itself and in the slits behind the skirting-boards and in the air filters of varying types.

In for example a two-storey small house the circulation air duct can be of a diameter of 300 mm. This single duct constitutes the ductwork for the entire heat installation.

The installation achieves a big circulation air flow without the need for a especially big fan capacity. Moreover all fan energy is brought into the building and contributes to the heating of the house. Therefore the air transport is very energy-efficient. So far the installation consists of known but newly developed techniques.

The outdoor air intake in this example is done through the building roof insulation, with arrangement for air collecting below the insulation: A space arranged beneath the insulation, downwards limited by a lowered ceiling equipped with a gas tight fabric sheet towards the living rooms.

In this space there must prevail a relative strong vacuum to overcome the necessary air resistance of the air distributing membrane below the insulation.
Via a collecting box with good connection to the above mentioned air collecting space, the outdoor air conducts through a ventilation duct into the circulation air duct.

The exhaust air evacuates the usual way with help of an exhaust air fan from the wet-rooms of the building and is conducted outside the building. If required with some kind of energy conserving. The exhaust air will not in any way be mixed again with the room circulating air.

The circulation air flow in such an installation average about 2 to 4 air change rates per hour ("one air change rate" corresponds to the volume of the building) meanwhile the stated ventilation air flow (in Sweden) is 0,5.
The circulation air flow is accordingly about 4 to 8 times greater than the ventilation air flow.

A solution according to the invention is to collect the different air masses ahead of the heat unit.
It is easy to be aware that the air resistance for the outdoor air intake is bigger than the resistance from a decorative protective grating, which covers the circulating return air inlet.
To obtain a suction effect, when using the simplest application of the invention, for conducting in outdoor air, the circulation return air flow must be given an extra resistance which is made in accordance to desired quantity outdoor air which will be transferred into the building.
The problem with this is that you, when using too small openings or too small dimensions in the circulation air duct work, risk a jarring sound caused by too high air velocity.
This is a very common reason for irritating noise from ventilation installations. Because of this you don't want to reduce the return air inlet towards the living rooms.
The conclusion is that in first place the dimension of the outdoor air duct intake ought to be enlarged. After that the returning intake side will be made as small as possible without disturbing air noises arising.

Fine adjustment of the air flows into the common air duct for ventilation and circulation air will suitably be done with help of a damper.

Another solution of that kind of installation

The following will demonstrate a special performance of the components of ventilation and installation.

At installations, described above, with room circulating air with supply air through a structural floor/structural floors, which installations have considerably bigger air circulation flows, the pressure drop can become too large and too abrupt between the room and the returning duct, as the room has a considerable greater cross-section area, compared to the flow direction, than the returning air duct has.

The pressure drop inside the duct can also occur on a short distance if the heat unit is located close to the duct's inlet opening. It can be hard to find the correct position for the inlet of the outdoor air into the duct.

The invention also gives solutions on this.

There is a useful dimension change in our invention, located close to the circulation air return intake from the living rooms.

A mixing box, which is positioned in close connection to the circulation air return intake and with a cross-section area compared to the duct system of bigger dimension, can serve as a dimension change and a connection with the circulating air and the outdoor air.

This mixing box gives room for a rather big returning air opening in order to maintain low air speed towards the living rooms and this can be designed to be sound-absorbing as i.e. a labyrinth inside and with walls covered with sound-absorbing material.

An outer covering of hard sound reflecting material gives a first class silencer. This gives at the same time a moderate air speed inside the mixing box, relatively equal to the speed which prevails in the living rooms. And by that a controlled vacuum.

From the mixing box a (relatively big) duct conducts the circulation air with mixed ventilation air onwards to filter and a heat unit.

A number of variants on performance of how the outdoor air duct is connected to circulation air the duct inside or beneath the mixing box, are described in the performance example and in the drawing figures further on in this application.

But there is also an another possibility to introduce the outdoor air into the circulation air with help of the mixing box.

In the area around the outlet opening (towards the circulation air fan) from the mixing box, inside the very mixing box, there is a bigger area where the pressure falls as the air speed increases towards the opening.

The outdoor air outlet will be positioned inside the area or the pressure drop close to, or in front of, the circulation return air duct conducting to the fan unit outlet opening, or with a part in inside said duct.

The outdoor air outlet adjusts to the correct position so that the desirable flow through that attains and locks in this position.

Inside the mixing box the outdoor air duct can be designed to rotate, turn, tilt or be lengthened with simple standard components for a simple adjustment.

The alternative above, the insertion of the outdoor air duct slightly into the returning air duct, also involves the returning circulation air flow area decreasing and that the air speed increases as the outdoor air duct demands space inside the circulation duct. With this simple arrangement, dimension changes don't demands on the circulation return air walls.

A comparison with other known patents

US 5,632,675 exposes a particularly favourable way to evenly mix two air flows A, C (which has big cross section areas). Nothing essential exposes concerning their building heat system.

US 4,399,864 shows a building with a classic design according to which part of the exhaust air brings back to the supply air flow by means of damper operation control. Supply and exhaust air flows are operated by fans, and some intake of outdoor air without the use of a fan, they don't reveal.

US 5,643,077 shows a spray-coat box with circulating air flow. When the solvent percentage in the air flow become too high, a diminutive part of the constant air flow is lead off and replaces a part of a corresponding supply air flow, wherein control devices see that the supply air flow will be exact, so that the circulation flow shall be maintained constant. There is no heat unit, and the exhaust air is lead off out from the circulation air duct on its upstream flank.
If that construction is used in a house the adjustment becomes troublesome in order to avoid embarrassing pressure variations in the recirculating air mass between the circulating duct's inlet and outlet.
The cited arrangement lacks the necessary grade of openness to prevent over pressure conditions to arise in a buildings residential area as the exhaust air is being led out from the returning duct for circulating air.
In a residence (or an office) exhaust air never turns off from a circulation duct in return. The exhaust air is always taken away from wet premises which has the "worst" = the most humid air in the living rooms and therefore you must create negative pressure conditions inside living rooms.
This space corresponds to the space in the spray-coat box itself where the colour is sprayed on and where no air such as in our invention is led out.

US 3,800,685 and US 4,448,111 shows an example of designs of venturi-ducts for different fields of application, anyhow no application field which is alike ours.

US 4,114,334 shows how with help of a supply air fan you conduct air out from boxes at a system of dynamic outdoor air intake. In our invention supply air fans are eliminated.

The invention, such as it is defined in the claim 1, has in this manner an essential novelty because of the absence of an air intake fan in the outdoor air duct, and because that preparation according to the claim 1 is made to allow an air circulation fan to bring forth the intake of the outdoor air in a stable and adjustable way.

The invention offers sucking in of outdoor air in a relatively large numbers of flow rates, either by means of an eligible adjustment of the distance between the the outdoor air duct outlet opening in relation to the circulation air duct's inlet opening, or by means of a venturi arrangement according to the dependent claims.

The invention, such as described in the claim 1, has structural novelty in comparison to the relevant earlier technique, and the novelty might be regarded as essential within the meaning of the patent law.

Other performances for the invention

There is every possibility of using the invention in the walls, also in similar cases which were described in the paragraphs above, when you wish to conduct the outdoor air through the wall insulation in stead of through the roof insulation. Example of applications are: multi floor residential properties with separate flats in levels. Also in this case proceed in principle as in the paragraphs above.

The system installations described above can be used advantageously for outdoor air, sun preheated in sun catchers, or behind the front cladding and/or below roof boarding, entering the building through openings and/or ducts.

The invention has above reported running in the winter, when heat supplies the building and when you try to reduce the entire energy consumption of the building.

In summertime a supply air fan consumes a considerable energy quantity unnecessarily as the building shall not be heated then. All emitted waste energy must be ventilated away. This disadvantage doesn't effect our invention as there is no need for a supply air fan.

The invention will in the following be described in example shape with reference to the drawings.

Description of the drawings

Fig 1 shows schematically a sketch of a FX-installation according to the invention. Heat and ventilation arrangement with a circulating air-flow 1, 2. containing a heat unit 5 with a fan 6, a branch off supply air duct 3 and ditto returning air duct 4.
The ventilation part contains a heat exchanger 7 for energy recovery and an exhaust air fan 9 with an appurtenant silencer 10. Exhaust air ducts 11 from wet premises.
In the figure, drawn with broken lines a supply air fan 8 with an appurtenant silencer 10 according to known technology: a FTX-installation. But the fan 8 is not needed in that installation with our invention.
Exhaust air is designated with 13, extract air with 14 (= exhaust air behind a heat recovery unit) and outdoor air with 15.

Fig 2A shows an arrangement according to the invention with the same functions as in fig 1, (without supply outdoor air fan and silencer). A suction apparatus 16 in the returning duct for the circulating air flow is shown. An adjustable damper 17 regulates the quantity of the supply air in cooperation with the exhaust air fan 9. The system changes by that into a so called FX-system.

Fig 2B an alternative location 16´ of the suction apparatus.

Fig 3 shows schematically, an example of a solution according to the invention of an air heat system with a design according to fig 4, a vertical section showing the outdoor supply air 15 is conducted through the roof insulation 19 to a sucker box 20 and further to a collecting box 18 and then into a mixing box through the supply air opening 22. An alternative way is showed, immediate from the space 20 below the insulation to the mixing box through the opening 22´.

Fig 4 shows schematically in a vertical section an arrangement according to the invention, an air heat system with circulating indoor air 1, 2 with supply air 1 through a stratified structural floor to get warm floors. Outdoor air intake through the roof insulation 19 via an air intake space 20 below the roof insulation 19, further through a gathering space the collecting box 18, and

further through a supply air duct 12, to a mixing box 21, designed as a sound-absorbing labyrinth, for mixing with the returning circulating indoor air 2.

The circulation flow 2 utilises the creation of a suction effect for the intake of outdoor air. The living rooms 25 and the mixing box 21 are separated by an open protective grating 36 and the sound-absorbing labyrinth 34 with a certain air resistance.

Fig 5 shows schematically in a vertical section, owing to the invention, the arrangement according to fig 4 but without a collecting box. The outdoor air duct 12 joins in immediate connection the space 20 below the roof insulation 19 and the mixing box 21.

Fig 6 shows in a detailed vertical section the connection between circulating indoor air 2 and outdoor air 15 according to fig 4 and fig 5. A contraction 26 in the circulation air duct creates a vacuum. The inlet 22 of the outdoor air duct 12 ends in the contraction 26. An adjustable throttle valve 17 in the outdoor air duct regulates the correct quantity outdoor air.

Fig 7 shows in detail the outdoor duct outlet opening 22 being positioned in the area of the pressure drop towards the circulation air duct's inlet opening 23 before the fan.

Fig 8 shows in a detail the outdoor duct outlet opening 22 being positioned slightly inserted in the circulation air duct 24 towards the fan. The outdoor air duct 12 subtracts area from the circulation air duct 24 wherein a contraction 26 with higher air speed forms.

Fig 9 The section area of the mixing box 21 forms the bigger duct area 29 and the circulation duct, with smaller area than the first, together forms the contraction 26, where a vacuum forms.

Fig 10 shows in detail, owing to the invention an arrangement in fig 4, fig 5 and fig 9, the connection of the outdoor duct 12 to the inlet opening 23 or the circulation duct 24. The inlet opening 23 is designed rounded 40.

Fig 11 shows in detail with an intersection how the outdoor air duct 12 in the example fig 8 is furnished with a tightening 27 in the end and holes 28 in the duct walls in the area inside the circulation air duct 24 towards

the fan and/or next to the outlet opening 23 of the circulation air duct towards the fan.

Fig 12 shows a detail of a contraction 26 with bigger cross section areas 29, 29´ on both sides and the connection of the outdoor air 12 duct to the circulation air duct 24. The outdoor air duct 12 has been inserted and is furnished with an opening 28 in the duct wall facing the direction of flow.

Fig 13 shows a detail of the outdoor duct end 27 in inserted position 32 inside the circulation duct reaching separate air layers of different velocity flow for adjustment of the suction effect.

Fig 14 shows a further detail of the outdoor duct end 22, equipped with slanted end 33, in suitably inserted positions 32 inside the circulation duct reaching separate air layers of different velocity flow, and in appropriately turning 31, for adjustment of the suction effect.

Fig 15 shows a further a detail of a contraction, a spray nozzle shaped inset being positioned inside a T-joint. The outdoor air duct 12 is connected on the side duct. In the contraction part 26 of the spray nozzle inset, holes 28 have been made so that outdoor air can flow around the spray nozzle in the space 47 which has occurred between the wall of the circulation duct and the spray nozzle wall, and then flow in through the holes 28 into the circulation duct.

Fig 16 shows an exploded view in perspective, a design of an air heater in function modules to fit the system in the figures 3 up to and including 5 and fig 9.
Uppermost a box shaped suction module 18. Below that a turnable mixing module 21.
An air tempering unit 5 below contains for example a rough and a fine filter 41, a circulation fan 6 and a heat unit 42.
Below the air heat unit is shown a sound-absorbation module 35. This can when necessary contain a cooler, or a cooling coil 43, for air conditioning. The bottom 44, which can be turnable, has recesses for a supply air duct or recesses with adaption to beams in the structural floor.

Description of an **example of performance**

You ought to note down that, in the following description, you can also in the airborne heat systems connect the outdoor air duct to a contraction 26 in the supply air duct 1 if that appears more suitable.

Fig 1 shows schematically a sketch of a F-X installation according to the invention.

A heat- and ventilation arrangement with a circulating airflow 1, 2 for example inside a house. The heat arrangement contains a heat unit 5 with fan 6, a branch off supply air duct 3 and ditto a returning air duct 4.

The ventilation part contains a heat exchanger 7 for energy recovery and an exhaust air fan 9 with an appurtenant silencer 10. An exhaust air ducts 11 from wet premises.

The connection between the supply duct for outdoor air 12 and the mixing in the returning duct 4 of the circulation system is open.

The outdoor air opening 22 (a second inlet opening 22) is to be positioned in the area of the pressure drop in front of* one of the circulation ducts inlet openings 30 (a first inlet opening 30) in order to create a suction effect in the outdoor air duct with help of the circulation air fan 6, so that together with the exhaust air fan 9 in adjusted cooperation create a suitable vacuum in the building.

* In practise you can let the exhaust air duct emerge above the inlet opening 30 and the let the heavier outdoor air "be caught" by the circulation duct.

Exhaust air is designated with 13, extract with 14 (= exhaust air behind a heat recovery unit) and outdoor air with 15.

The heat exchanger can be of a known heat conducting kind for example a sheet metal heat exchanger, or a heat pump heat exchanger (with or without an additional source of heat) which conducts energy from the exhaust air to incoming outdoor air, or the reverse cooling during the hot season.

If the installation contains a supply air fan 8 (drawn as a broken line) the installation becomes a so-called FTX-system according to known technology.

Fig 2 A shows an arrangement of a design similar to fig 1, according to the invention. A suction apparatus 16 according to the invention on the returning duct for the circulating air

flow. There connects the outdoor duct 12 opening 22 (a second inlet opening 22).

An adjustable damper 17 regulates the supply air quantity and by that the correct vacuum inside the building in inter linked cooperation with the exhaust air fan 9.

The system changes by that into a so called FX-system, but with the FTX-system's positive characteristics, but not with one of its disadvantages, maybe the biggest, the need for a supply air fan which is expensive in purchase and in operation and with generation of noise.

Fig 2 B An alternative location 16´ of the suction apparatus, next to an inlet opening 30.

Fig 3 shows schematically, an example of a solution of an air heat system of a design according to fig 4, a vertical section showing the supply outdoor air 15 from the roof. The outdoor air is taken in through a collecting box 18 and conducts into a mixing box 21 through an inlet opening 22 (a second inlet opening 22). The circulation air in return 2 conducts through a protective grating furnished opening 30 (a first inlet opening 30) into the mixing box 21, which forms a lengthening of the circulation duct 24, and further to the circulation air fan 6. An alternative location, of the inlet opening 22´ direct from the space 20 below the insulation 19, is also shown.

Fig 4 shows schematically in a vertical section a system according to the invention, as air heat system with circulating indoor air 1, 2 with supply air 1 through stratified structural floor for warm floors.

The outdoor air 15 passes through the roof insulation 19 and via a space 20 below the roof insulation 19, further through a collecting box 18, and further through a supply air duct 12, to a mixing box 21 for mixing with the returning circulating indoor air 2. The mixing box 21 serves an additional function with the design as a sound-absorbing labyrinth 34 at the same time it is a part of the returning duct for the circulation air 2.

The figure shows, in an example performance according to the invention, how the circulation return flow 2 is used to create a suction effect for the intake of outdoor air, without the need of a supply air fan for outdoor air.

The arrangement at the outdoor duct 12 connection to the circulation ducts 24 towards the fan inlet opening 30 (a first

inlet opening 30) is demonstrated in detail in fig 6, 7 and 8 and fig 10.

Please observe that openness prevails between the living rooms 25 and the mixing box 21 because these spaces, to judge by appearances, only are separated with an opening of for example a grating 36 with small air resistance (a first inlet opening 30) and where the returning circulation air 2 is sucked in.

A sound-absorbing labyrinth 34 with certain air resistance gives correct conditions for some lower pressure to prevail inside the mixing box than inside the living rooms so that the system shall be controllable and that the circulation air fan shall not be able to pump in a too big quantity outdoor air and cause over pressure inside the building. The outdoor air ducts 12 opening 22 (a second inlet opening 22) has been positioned in the area of the pressure drop in front of the circulation ducts 24 inlet opening 23 inside the mixing box.

Fig 5 shows schematically in a vertical section according to the invention the system according to fig 4 without the collecting box.

A outdoor air duct 12 connects the space 20 below the roof insulation 19 straight to the mixing box 21.

Fig 6 shows in vertical section detail of the connection between the circulating indoor air 2 and the outdoor air according to fig 4 and fig 5. A contraction 26 on the circulation air duct creates a vacuum. The outdoor air duct 12 inlet 22 opens out inside the contraction 26. An adjustable throttle valve 17 on the outdoor air duct creates a certain pressure drop to give the correct quantity outdoor air.

Fig 7 shows in detail the outdoor duct outlet opening 22 being positioned in the area of the pressure drop before the circulation air ducts in front of the fan inlet opening 23.

Fig 8 shows in detail the outdoor duct outlet opening 22 being positioned slightly inserted in the circulation air duct 24 towards the fan. The outdoor air duct 12 subtracts area from the circulation air duct 24 wherein a contraction 26 with higher air speed forms. The central location of the opening 22 inside the circulation duct gives favourable conditions for the outdoor air to flow in into the circulation duct.

Fig 9 When using big circulation duct areas 24 for example in immediate connection to a heat unit 5, the circulation air ducts outlet opening 24 can be located alongside of the bottom of the

mixing box 21. Together the section area of the mixing box 21 which forms the bigger duct area 29 and the circulation duct, with smaller area than the first, forms the contraction 26, where a vacuum forms.

In this performance example the circulation duct to the fan unit 24 has been shown with constant cross section and shapes accordingly partly the contraction 26 and partly the connection 24 to the fan.

Fig 10 shows a detail, according to the invention, of the system in fig 4, fig 5 and fig 9, of the outdoor duct 12 connection to the circulation duct 24 towards the fan inlet opening 23. The inlet opening 23 is a rounded design 40 to partly reduce the air resistance at the air intake and partly so that, with the softer dimension change 40 you get a more calm flow and hence a not so abrupt a pressure drop, and enlarge the area for the outdoor duct 12 opening 22 location. For example so that the suction effect will not abruptly come to an end at a very small transfer outwards from the suction area.

Fig 11 shows in detail with an intersection how the outdoor air duct 12 in the example fig 8 is furnished with a tightening 27 in the end and holes 28 in the duct walls in the area inside the circulation air duct 24 towards the fan and/or next to the outlet opening 23 of the circulation air duct towards the fan. The location of the holes 28 gives outlet for the outdoor air 15 inside the contraction 26 which been formed between the walls of respectively duct 22, 24.

The size of the negative pressure can be adjusted by means of an axial insertion of the outdoor air duct 12 further in respectively farther away inside the circulation air duct 24.

With the arrangement: the outdoor air duct 12 is furnished with holes 18 outside the exterior of the circulation duct 24, the suction effect is gradually deteriorated below a longer distance along the outdoor air duct as the outdoor air duct is pulled out.

You maintain a larger adjustment area and less precision demands for the position of the outdoor air duct to get the correct air flow.

Even less sensitivity for fluctuations in the circulation flow.

Fig 12 shows a detail of a contraction 26 with bigger cross section areas 29, 29´ on both sides and the connection of the outdoor air 12 duct to the circulation air duct 24. In order to

increase the suction effect the outdoor air duct 12 has been inserted, when seen in radial or transversal direction compared to the flow direction and is furnished with an opening 28 in the duct wall facing the direction of flow. The purpose to of doing this is that the outdoor air shall be furnished in the middle of the duct where the biggest air speed prevails.

Fine adjustment can be brought about with a turning 31 of the outdoor air duct 12 and let the opening 28 take in different positions to get the correct suction effect.

Fig 13 shows a detail of the outdoor duct end 27 in inserted position 32 inside the circulation duct reaching separate air layers of different velocity flow for adjustment of the suction effect.

Fig 14 shows a detail of the end 27 of the outdoor duct, with slanted end 33, in eligibly inserted positions 32 inside the circulation duct 26 reaching separate air layers of different velocity flow, and in eligibly turning 31, for adjustment of the suction effect.

Fig 15 shows a detail of how a contraction with small air resistance been created through insertion of a spray nozzle shaped inset 45 inside a standard T-joint. The outdoor air duct 12 is connected on the side duct. In the more limited part 26 of the spray nozzle inset holes 28 have been made so that outdoor air can flow around the spray nozzle in the space 47 which has occurred between the wall of the circulation duct and the spray nozzle wall and then flow in through the holes 28 into the circulation duct. The air resistance inside the circulation duct will not increase considerably when you insert a streamlined spray nozzle.

The suction efficiency is adjusted by using different areas in the contraction 26 and by changing the size and the numbers of the holes 18. Cleaning of the ducts is facilitated if the nozzle inset 45 is dismantling.

Fig 16 shows an exploded view in perspective, a design of an air heater in function modules aimed to the arrangement in the figures 3 up to and including 5 and fig 9. The function modules are aimed to be assembled in tightened connection towards each other.

Uppermost a box shaped suction module 18 intended for tightened mounting towards the building ceiling towards the collection space 20 below the insulation. The suction box module has

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 99/01337

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SE 9401730 A	20/01/95	AU 2582995 A	18/12/95
		CA 2190639 A	30/11/95
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/01337

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Patent Abstracts of Japan, abstract of JP 7-190444 A (MATSUSHITA SEIKO CO LTD), 28 July 1995 (28.07.95), figure, abstract --	1-6
Y	Patent Abstracts of Japan, abstract of JP 6-272949 A (KAJIMA CORP), 27 Sept 1994 (27.09.94), figures, abstract --	1-6
A	FR 2599437 A1 (ROY, P.), 4 December 1987 (04.12.87), figures 1-2 --	1-6
Y	US 4448111 A (R. DOHERTY), 15 May 1984 (15.05.84), figures 1-6 --	1-6
Y	US 3800685 A (R. KITAMURA), 2 April 1974 (02.04.74), figures 1-4 -- --------	1-6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/01337

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F24F 7/00, F24F 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SE 9401730 A (G. WEGLER), 20 January 1995 (20.01.95), page 5, line 8 - line 9, figures, esp. 1A,3-3A --	1-6
Y	FR 2720484 A1 (SPIREC SOCIETE A RESPONSABILITE LIMITEE), 1 December 1995 (01.12.95), figures 1-3, corr. text --	1-6
Y	US 5636993 A (V.C. BADRY), 10 June 1997 (10.06.97), column 2 - column 5, line 13, figures 1-3 --	1-6

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2000	18 -04- 2000
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM	Authorized officer Heléne Eliasson / MR

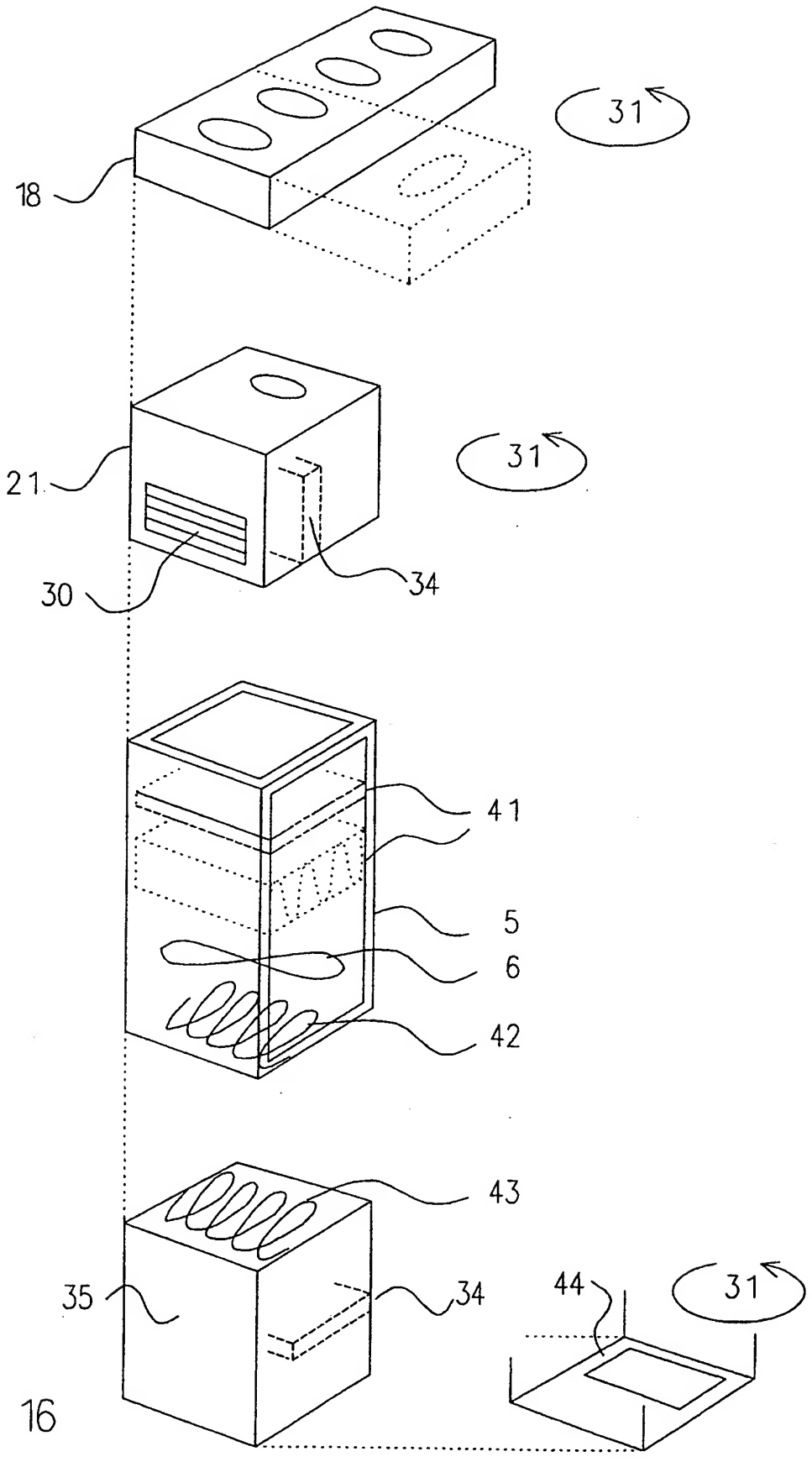

FIG 16

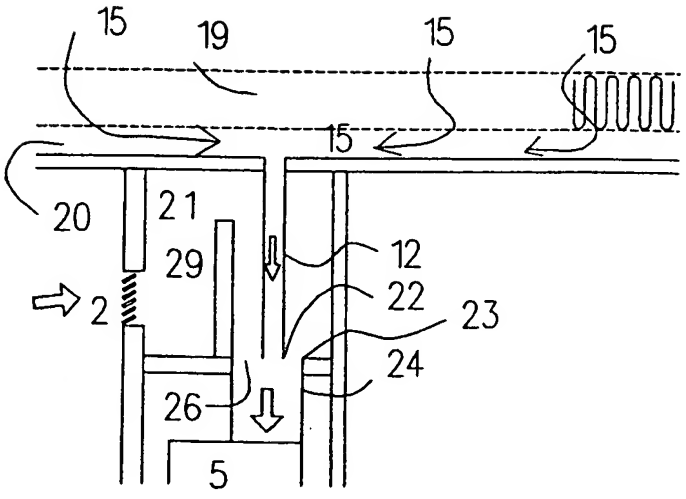

FIG 9

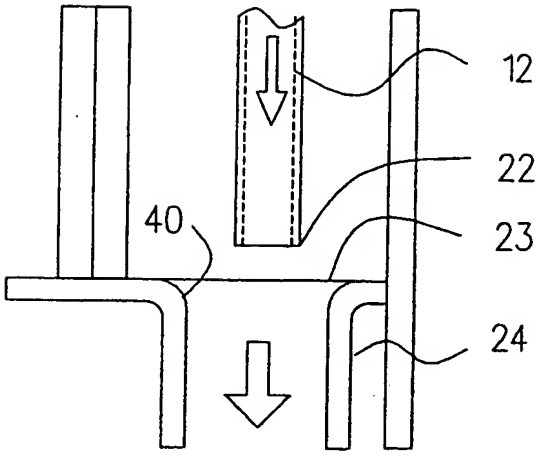

FIG 10

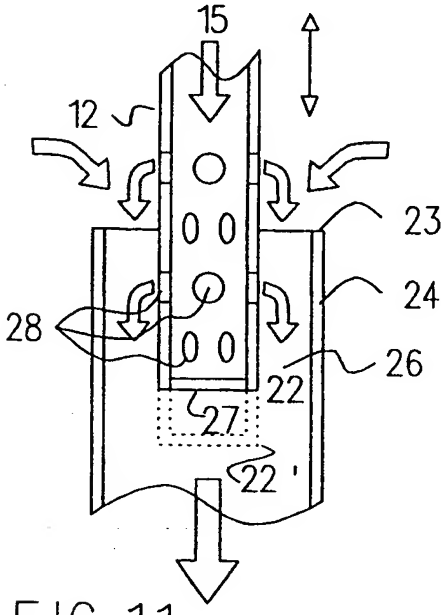

FIG 11

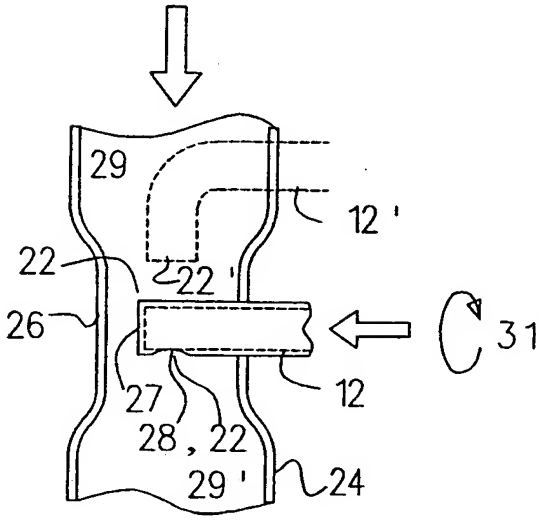

FIG 12

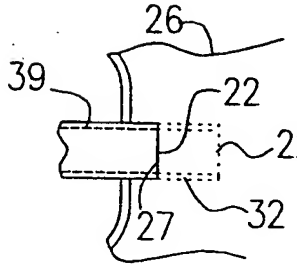

FIG 13

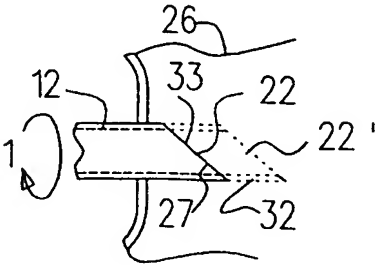

FIG 14

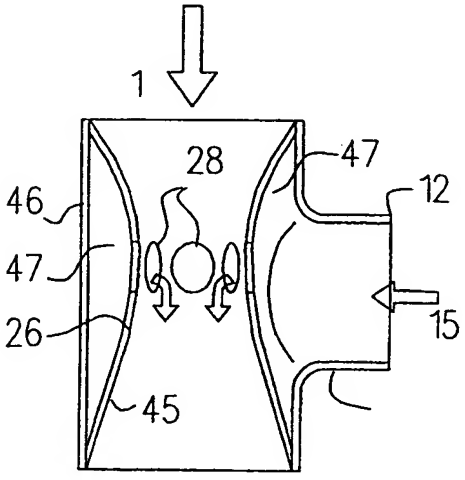

FIG 15

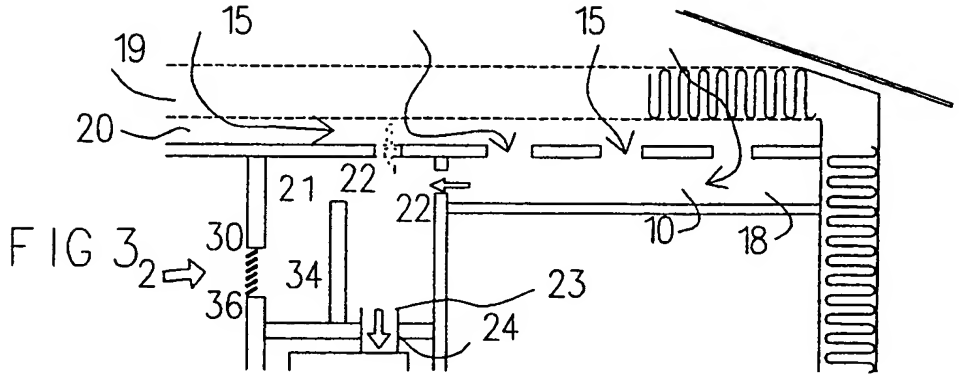

FIG 3

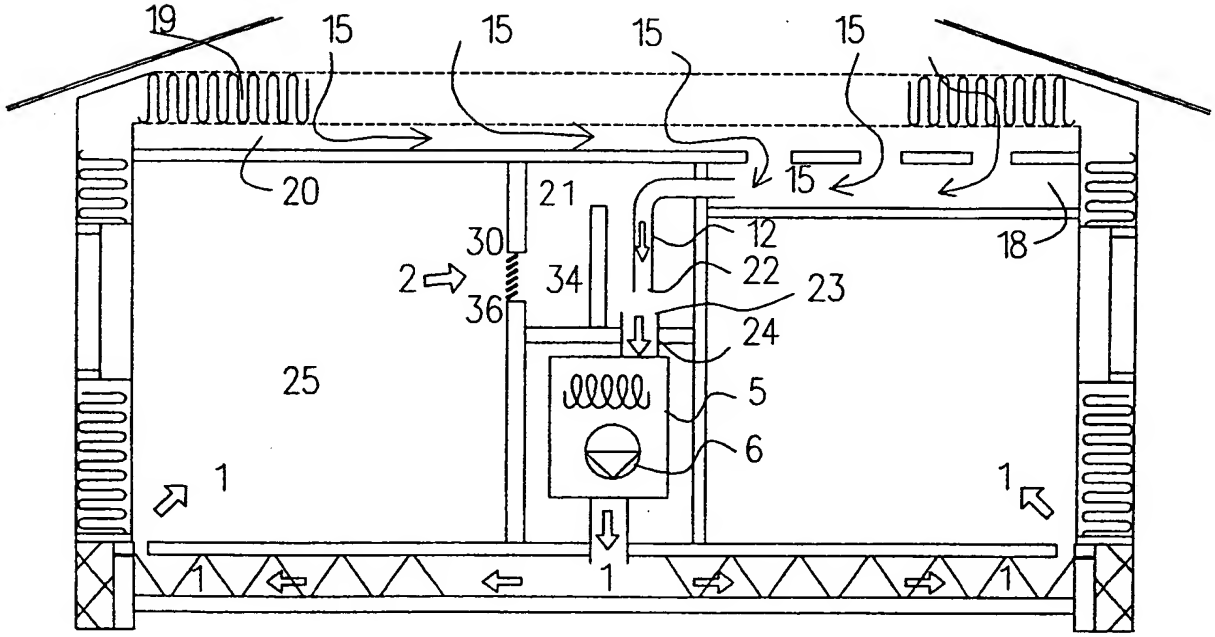

FIG 4

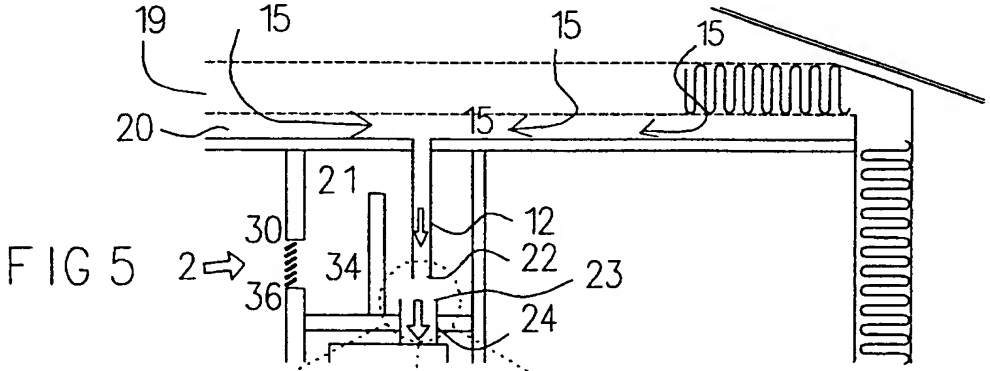

FIG 5

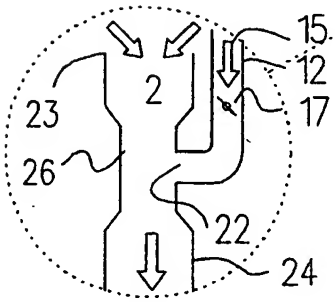

FIG 6

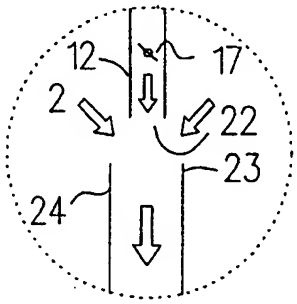

FIG 7

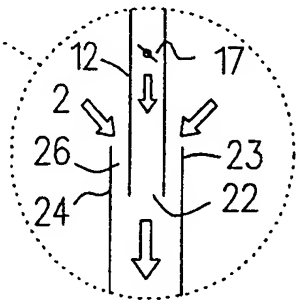

FIG 8

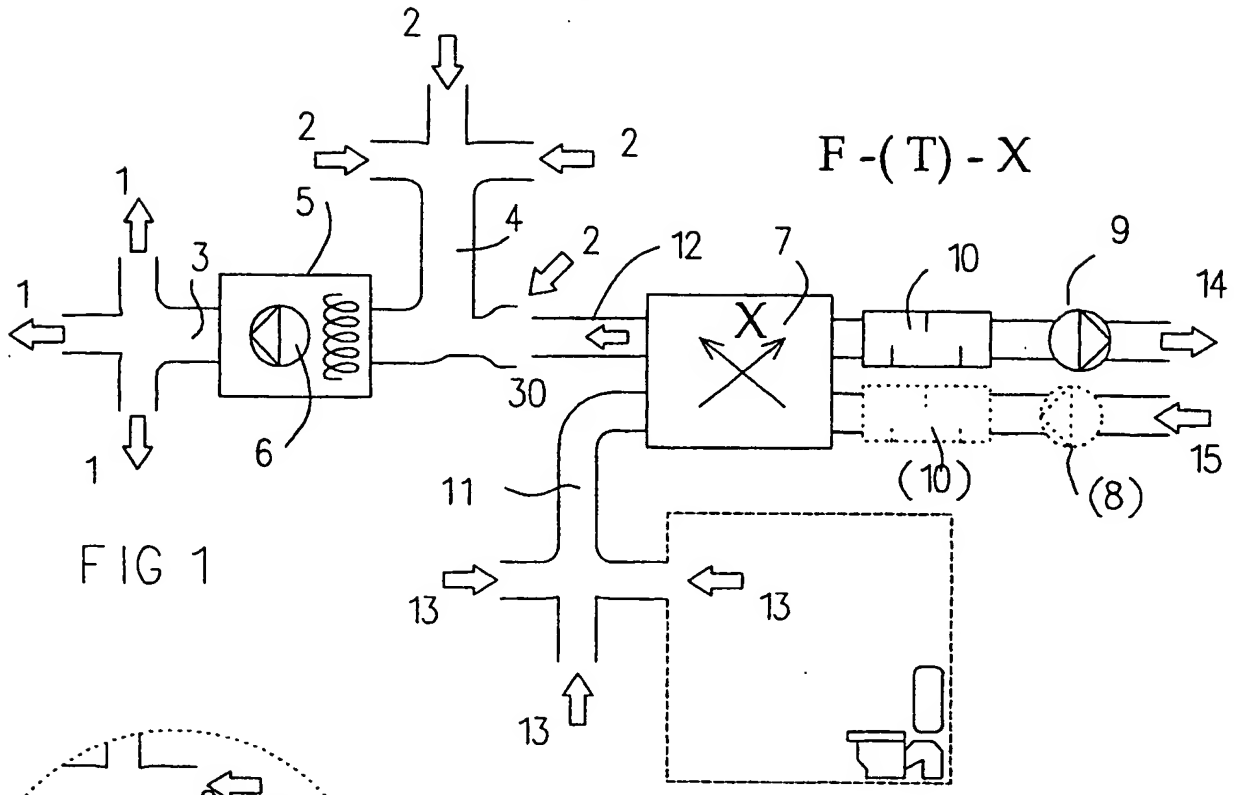

FIG 1

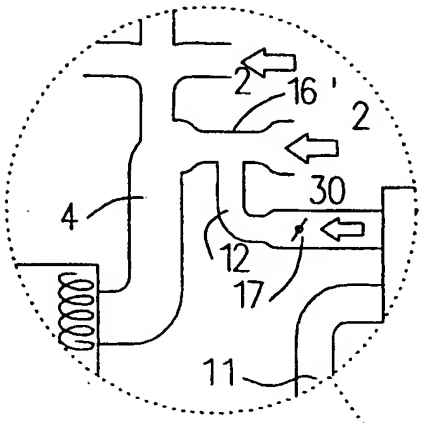

FIG 2B

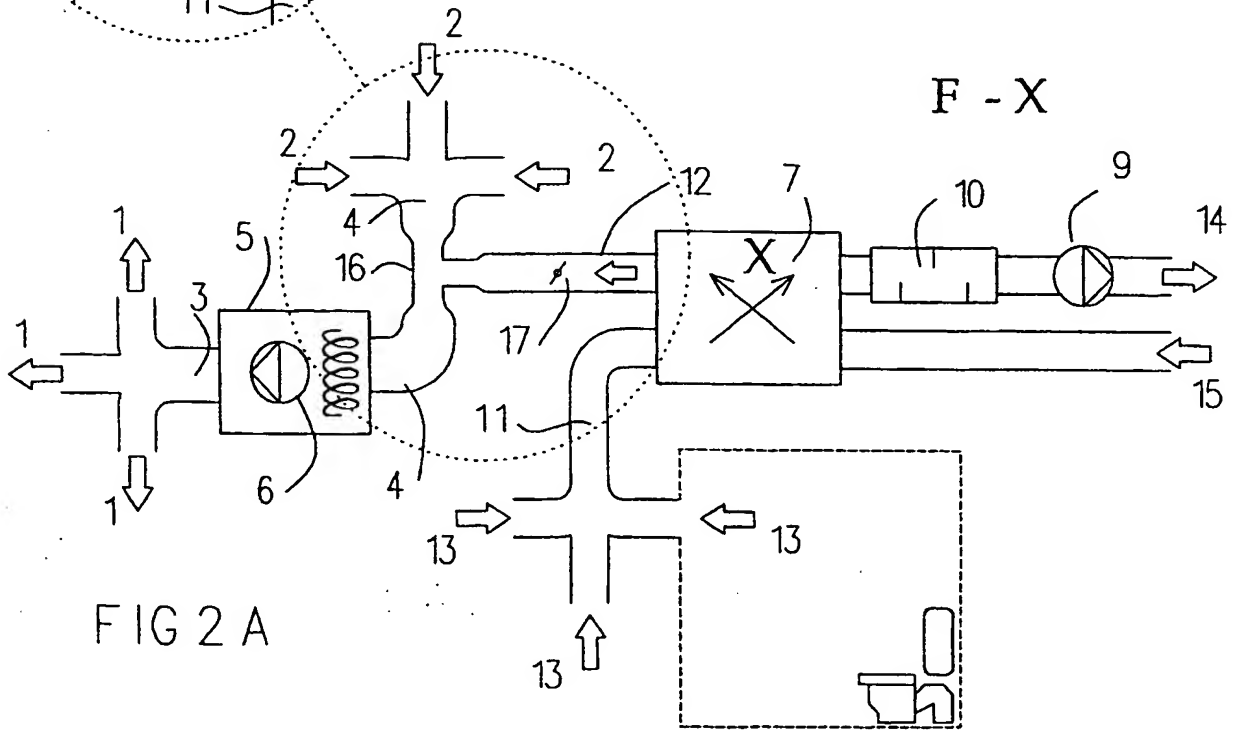

FIG 2A

Claim 5. A ventilation arrangement according to some of the above claims, **characterised** in a spray nozzle shaped inset (45) with its ends in tightened connection to the duct wall of the air circulation installation (3, 4; 21, 24) (46), and that the outdoor air (15) can flow between the air circulation duct wall and the inset wall around the narrower part (26) of the inset and flow in through openings (28) in the spray nozzle partition wall into the circulation air flow.

Claim 6. A ventilation arrangement according to some of the above claims, **characterised** in that the second the inlet opening (22) has an adjustable damper (17).

PATENT CLAIMS

Claim 1. A ventilation arrangement for a building, comprising an exhaust air duct (11) with a fan (9) wherein the duct (11) has evacuation devices, which are connected to wet rooms for air evacuation, and besides that the ventilation arrangement comprises a supply air duct (12) for intake of outdoor air into the interior of the building, and an air circulation installation for circulating of air (1, 2) inside the building, wherein the circulation installation comprises a circulation duct (3, 4; 21, 24) with a fan (6) and an air tempering unit (42; 43), wherein the circulation duct has a first inlet opening (30) upstream of the fan for intake of circulation air (2) from the interior of the building, and a second inlet opening (22) which is positioned upstream of the fan for intake of outdoor air (15), **characterised** in that the outdoor air duct outlet end opens out on distance from the edge of the circulation ducts first inlet opening, wherein the outdoor air duct outlet opening forms the said second inlet opening, and that the outdoor air duct does not contains any fan unit arrangement.

Claim 2. Ventilation arrangement according to claim 1, **characterised** in that the proportions between the area of the first inlet opening (30) and the area of the second inlet opening (22) is made adjustable.

Claim 3. A ventilation arrangement according to claim 1 or 2, **characterised** in that the second inlet opening is arranged near to the free end of the circulation air duct (4) connected duct part and that said duct part has a contraction (26), and that the outdoor air duct outlet opening (22) connects to the contraction.

Claim 4. A ventilation arrangement according to some of the above claims, **characterised** in that the duct of the air circulation arrangement (3, 4; 21, 24) contains a contraction (26) or a venturi designed tube (45) and that the supply air duct (12) opens up (22) in the contraction/venturi tube to admit outdoor air intake (15) with help of a venturi-effect which generates with help of the fan of the air circulation arrangement (6).

insignificant height as in this invention you don't need any supply air fan. It is turnable to be adapted to the house walls and interior decoration. Further it has a longish performance so that a wider area of the ceiling can be used for the outdoor air intake.

Below the suction module a mixing module is positioned. This is designed as a sound-absorbing labyrinth and has openings to connect the outdoor air duct from the suction module and for the circulation air from the living rooms. It has for example a quadratic plane section to be turnable horizontally for adaptation to the building interior and still suit to the heat unit 5 below which also is quadratic.

Other conceivable cross section areas are circular or octagonal.

The heat unit 5 below contains for example a rough and a fine filter 41, a circulation fan 6 and a heater 42.

Below the air heat/tempering unit, or inside this, if so desired, a further module can be located.

A sound absorbing part 34 is built in in a module 35. This can when necessary contain a cooler unit, or a cooling coil for the unit, for air conditioning. The bottom 44, which can be designed as turnable, has recesses for a supply duct or recesses with adaptation to beams in the structural floor. The module can also be made without a bottom and mounted in tightening connection to the structural floor board.

Even if in essential parts only a few of the design options of the present invention have been shown on drawings and described above, it should be understood that the invention is not restricted to these designs but are limited only to those indicated in the patent claims.